Future visions of medical neuroimaging

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Chapter 5

Abstract

We report findings of a media analysis regarding how neuroimaging research was framed in 307 Dutch newspapers articles published between 1992 and 2012, and the effect these might have on their readers. Our results show that neuroimaging research is mainly presented as providing insights and solutions for societal problems and as such should be supported. Topics of concern and debate mainly relate to applications outside the medical realm such as brain-based explanations of social beliefs and phenomena, and non-medical related behaviours and dysfunctions.

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The framing of neuroimaging in the Dutch media: promising futures or monstrous images?

5.1 Introduction

Innovations in the field of neurosciences are increasingly affecting people's lives. They have the potential to provide answers to questions about ourselves, our health, the social world we are part of and to lead to improved health and economic benefits (O'Connell, et al., 2011). Brain-based explanations and applications go hand in hand with neurosciences as a thriving research discipline[9]. Neuroimaging technologies play a large part in this by offering the prospect of increased understanding of the brain and its disorders and, subsequently, of new and improved options for clinical applications (e.g. Ewers et al., 2011; Szymanski et al., 2010; Willmann et al., 2008). Neuroimaging comprises those technologies that directly or indirectly visualise the structure, function, connectivity and biochemistry of the brain. Examples are functional Magnetic Resonance Imaging (fMRI) and Positron Emission Tomography (PET). Their ability to visualise processes in the brain and to generate compelling images thereof, has aroused interest from the public and the media (O'connell, et al., 2011).Moreover, neuroimaging is no longer exclusively linked to the medical domain, but has extended to domains widely beyond it, such as neuro-law[10], neuro-marketing (Lee & Broderick, 2007) and neuro-education (Wolfe, 2010).

In a survey among UK citizens most respondents (83%) had at least 'a little' awareness of neuroimaging use (Wardlaw, et al., 2011). As has been explained elsewhere, it is not so much familiarity with a technology that drives perception. Rather, it is fuelled by psychological mechanisms and cultural cognition that are always ready to form an opinion instantly when necessary (Kahan et al., 2009; Druckman & Bolsen, 2011; Fiske & Taylor, 2008; Scheufele & Lewenstein, 2005). Media coverage of emerging technologies is the most likely provider of information on which opinions will be

[9] Consider, for example, the Human Brain Project selected as a European Flagship in 2013 (www.humanbrainproject.eu). Also on the Dutch national level, the Netherlands Organization for Scientific Research (NWO) awarded eight out of 32 Vici grants to brain and cognition researchers (www.nwo.nl/vi).

[10] http://lawneuro.org/blog/category/neurolaw/

based (Scheufele & Lewenstein, 2005). But how does the media frame neuroimaging? In this article, we consider the framing of neuroimaging research in Dutch newspapers published between 1992 and 2012, and focus on the potential performative force these framings might have on the discourse surrounding neuroimaging technologies.

5.2 Public perceptions, neuroimaging and the printed media

In perception formation of the general public, the media, and newspapers in particular, are a primary source of information regarding scientific and technological developments (Nelkin, 1995; Rogers, 1999; Becker et al., 2000; Best & Kellner, 2001). This is especially so when these are in their early phases of development (Nisbet & Lewenstein, 2002). How people interpret media coverage depends on how an item is presented (Scheufele, 1999; Scheufele & Lewenstein, 2005). This is known as media framing. For example, "two news stories that present the exact same content may be interpreted differently by audiences, simply based on their mode of presentation" (Scheufele & Lewenstein, 2005, p. 660). Subsequently, how an issue is framed has an effect on the expectations and concerns that are raised and which course of action is invited or blocked from view (Nerlich & Jaspal, 2012). Through frames, the media thus actively demarcates "what will be discussed, how it will be discussed, and above all, how it will not be discussed" (Altheide, 1996, p. 31). As such, framing can "mobilize the future into the present" (Brown, 2003, p. 6). Exploration of existing and emerging frames of neuroimaging in the media can therefore give insights into potential future tensions and topics of debate. Moreover, insights into (emerging) media frames offer opportunities for stakeholders, and neuroscientists in particular, to anticipate to miscommunication of their findings to the public and hence to reduce the risk of unrealistic expectations and ethical or social concerns (Racine et al., 2010; O'Connell, et al., 2011).

Previous research on English language media coverage of neurosciences and neuroimaging showed, overall, optimistic and neutral points of view for neuroimaging use. This is mainly attributed to the failure of articles to address scientific, technical and ethical issues (Racine et al., 2006; O'Connell, et al., 2011). Furthermore, Racine and others (2005 and 2010) identify three main framings of neurosciences in the media: *neuro-essentialism* (the brain is the self-defining essence of a person), *neuro-realism* (neuroimaging provides direct data, such as visual proof, of brain function) and *neuro-policy* (the use of neuroimaging in the policy realm). (Nelson et al., 1997). O'Connor et al. (2012) identified in their analysis of mainstream media

also three major framings of neuroscience in the media: the *brain as capital* (a resource to be optimised), *the brain as an index of difference* (delineates boundaries between categories of people) and *the brain as biological proof* (material, neurobiological basis of particular beliefs or phenomena). Without elaborating on the differences between these framings, these studies describe how neurosciences/ neuroimaging and subsequently the brain is framed in the media. However, it remains unclear what the potential influence of these different framings is on public opinion regarding neuroscience/ neuroimaging research itself and its outcomes (i.e. support, reject). Moreover, there has not yet been an analysis of the framing of neuroimaging in the Dutch media.

The research presented here is part of a project which aims to manage and realise more responsible neuroimaging innovations in an early phase of development in order to facilitate an appropriate societal embedding. Our aim in this study is to find framings of neuroimaging research in the Dutch media that might have a performative force in the discourse surrounding neuroimaging technologies. For the purpose of this study, we understand this 'performative force' as the effect that the framing of neuroimaging research in the media has on the reasoning and behaviour of their public(s). Following Nelson et al. (1997, p. 221) and Nerlich and Jaspal (2012, p. 134), we consider framing as: "the process by which a communication source, such as a news organization, defines and constructs a [scientific finding], political issue or public controversy". Considering the early phase of neuroimaging developments, we focussed on how neuroimaging *research* and the potential applications that might result from this research were positioned in newspapers to gain insight into emerging and existing frames of neuroimaging in the media.

5.3 Methodology

5.3.1 Data collection

To gain insight into how neuroimaging research is positioned in the Dutch media, we generated a selection of Dutch newspaper articles using the LexisNexis Academic database (academic.lexisnexis.nl). This database contains full-text access to newspapers, both national and regional, dating back 30 years[11]. We searched for Dutch-language articles published before 31 December 2012 containing at least one neuroimaging modality related keyword, such as 'neuroimaging', ' brain scan',

[11] http://www.lexisnexis.nl/dutch/products/nexis.page

'fMRI', or 'functional magnetic resonance imaging' [12], accompanied with occurrences of 'science', 'research' or 'study' within the same sentence and having 'brain' or 'cognition' in the body text.[13] As this search query yielded too many sources (>3000 articles) for qualitative analysis and to increase relevancy, we narrowed the search to occurrences of 'brain' or 'cognition' in titles and lead paragraphs and introduced the additional requirement of at least two occurrences of 'brain' or 'cognition', and of 'science', 'research' or 'study'. During these subsequent steps, we controlled whether the a-selectivity of the corpus was not affected, by exploring the proportion of articles per newspaper compared to the corpus of articles. To further reduce the sample size (> 2000 articles), we subsequently selected the four national newspapers with the highest circulation rates (*De Volkskrant*, *Trouw*, *NRC Handelsblad*, *De Telegraaf*) for reasons of geographical coverage, as well as their apparent influence on other media coverage (Nisbet & Brossard, 2003). To allow for ideological and geographical diversity, we also included a Christian national newspaper (*Reformatorisch Dagblad*) and five regional newspapers distributed over the Netherlands (*De Gelderlander*, *Noordhollands Dagblad*, *Dagblad De Limburger*, *Dagblad van het Noorden*, *Brabants Dagblad*). This resulted in a corpus of 398 articles. After removal of duplicates arising from the use of multiple keywords, republication of articles and exclusion of those articles that did not describe neuroimaging research outcomes, 307 unique articles remained.

5.3.2 Analysis

A random selection of 21 articles of the corpus was independently open labelled by two researchers (IMJ and MEA) as a first step in our qualitative analysis. Previously used coding categories of neuroimaging in the media (Racine et al., 2006 and 2010) were used as a starting point and amended and complemented throughout the coding process. Other codes were identified as they surfaced from the data. The resulting codes were discussed and a preliminary coding guide was constituted. Second, the corpus of articles was independently coded with qualitative data analysis software (MAXQDA 11). The coded texts were discussed until consensus was reached and

[12] Due to the adaptation of English terminology in Dutch language both English and Dutch wordings were incorporated when relevant. Other modality keywords included Positron Emission Tomography (PET), Single Photon Emission Computerized Tomography (SPECT), electroencephalography (EEG), transcranial magnetic stimulation (TMS), MRI, brain image, and brain activity.

[13] Dutch translations of 'brain scan', 'science' or 'scientific', 'research', 'study', 'brain' and 'cognition are 'hersenscan', 'wetenschap', 'onderzoek', 'studie', 'hersen' and 'cognitie' respectively. Except for 'hersenscan', a Lexis Nexis truncation operator was used to allow for variations of the search term.

coded segments were adjusted accordingly when appropriate. When necessary new codes were defined. Box 1 shows the final coding guide.

Analysis of the corpus of articles resulted in insights into how neuroimaging research and its outcomes were defined and constructed in our selection of Dutch newspapers, and which influence this might have on those reading the article. We were able to identify a dominant frame from which neuroimaging research is positioned, namely from a medical perspective. This is in line with the research of Racine et al. (2006 and 2010) and O'Connor et al. (2012).

Box 1. Coding guide

The final coding guide contained the following coding categories:
a) the newspaper and section in which the article was published;
b) publication date;
c) cause of publication (news items or opinion/response item);
d) described neuroimaging modality;
e) cohort to which presented neuroimaging technology was applied (e.g., patients, gamers);
f) concepts used to describe neuroimaging research outcomes (e.g. brain area, network);
g) frames used to describe neuroimaging research (medical, non-medical, boundary);
h) the framing of neuroimaging research outcomes;
i) the framing of neuroimaging research as a practice;
j) the potential performative force of the article.

Codes a-d were generated by auto-coding and checked by the researchers. Codes e-j enabled in-depth qualitative analysis of the articles.

To further explore potential emerging frames which could give rise to future tensions and topics of debate, the two researchers executed a second analysis in which articles describing neuroimaging research within a medical framing were separated from those that were written within a non-medical framing and from those that that contained medical and non-medical framings. For each article consensus was reached regarding the framing used to describe the presented neuroimaging research. With this we aim to go beyond a merely descriptive media analysis. By analysing different framings in the same article in-depth, we qualitatively explored the likely effect the framing of neuroimaging research in the media might have on their readers.

To assess the presence of any statistically significant associations between (categorical) codes, we conducted a Fisher's Exact Test (two-tailed), with a p value of $< .05$ indicating statistical significance (Mehta & Hilton, 1993).

5.4 Results

5.4.1 General sample characteristics

Our selection contains 307 unique articles spanning the time frame of October 1992 to December 2012. No articles were found prior to October 1992 using the selection criteria. 77% of the articles were published between 2005-2012. About half of the articles (n= 138) were found to be published in a general or unspecified newspaper section. The other half of the corpus, 131 articles, was placed in a science, knowledge or education section. The remaining articles were published under the heading of opinion (n=7), health and wellbeing (n=12), religion, culture and philosophy (n=10) and 9 articles were positioned on the front page. From the 307 articles, 283 articles (92%) report about the possibilities of neuroimaging research (e.g. the possibility of visualising x). 24 articles (8%) were written in response to earlier publication(s) ('response articles') with a reference to neuroimaging research and describe the (potential) disadvantages and consequences of neuroimaging research.

The neuroimaging modality usually described is fMRI (mentioned in 186 articles), followed by EEG (40 articles) and PET (26 articles), all published from 1995 onwards In the majority of the articles (n=282) concepts such as 'brain areas', 'networks' and 'processing' most frequently combined with concepts such as 'activity' and 'reactions' of the brain, or *vice versa,* have a central place. In only 8 percent of the articles (n=25), brain research or brain scan was the only reference to neuroimaging research. Use of the concepts 'brain area' and 'brain activity' is constant over time in the articles, whilst use of the concept 'brain structure' declines after 2003 and use of the concept 'network' increases from 2005, see Table 5.1. The purpose of the research presented in the articles is mostly to benefit patients. Neuroimaging research for this purpose was executed with patients or healthy volunteers. Other groups that were mentioned to which the research outcomes could be applied to are adolescents, elderly, children (mostly also from a medical perspective) but also consumers, artists, gamers and astronauts.

Table 5.1. Used concepts in describing neuroimaging research with respect to the brain over time

year	1992	1994	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
use of concept																			
brain area	50%		20%	33%	25%	20%	25%	38%	38%	9%	9%	16%	21%	46%	46%	42%	44%	31%	33%
brain structure					25%		13%	25%	13%	9%			7%	4%	4%		4%	2%	6%
brain activity	50%	100%	40%	67%	75%	20%	75%	13%	25%	36%	55%	58%	48%	42%	54%	50%	52%	57%	42%
brain function				33%				25%		9%		5%	10%	17%	7%	3%	4%	7%	6%
network												5%	10%	13%	7%	11%	16%	10%	8%
anatomy										9%		5%	3%	4%		3%			
brain volume								13%	13%	9%			3%			5%			3%

5.4.2 Changing frames

88 articles are written from an exclusively **medical** perspective. Articles within this frame have a purely medical focus: the outcomes presented in these articles show medical knowledge, insights and or (expected) new and improved diagnostic, cure and care options. The majority of these articles focus on mental disorders (n=26), neurodegenerative disorders (n=22) and acquired brain injuries (n=19). Other articles contain outcomes from neuroimaging research into behavioural disorders, migraine, pain and chronic fatigue. All articles present disorders from a purely medical perspective, meaning, for example, that whether a disorder can or should be classified as a medical disorder is not questioned. The disorder is simply presented as such.

107 articles describe **non-medical** neuroimaging research. This category consists mainly of articles presenting basic research regarding the working and development of the brain (n=53) without referring to potential future medical insights and/or applications. Remaining articles (n=54) address a more applied aspect of neuroimaging research outcomes with respect to free will, mind-reading, decision-making and related lie-detection and neuromarketing applications (n=39), meditation, near-death experiences, and religious experiences (n=10) and male-female differences (n=5).

112 articles describe neuroimaging research within a mixture of a medical and a non-medical frame. We will henceforth call these articles '**boundary articles**', as they seem to transgress a border between the medical and the non-medical realm. Illich (1975) started the long lasting debate on the medicalisation of society. This concerns the advantages and disadvantages of an extension of the border demarcating illness from health and the subsequent related techno-somatic approaches, interventions and solutions. In-depth analysis of the boundary articles might provide insight and understanding of emerging frames of neuroimaging research regarding the current extension of this border and related future topics of concern and debate in the media.

5.5 In-depth analysis of boundary articles

Within the set of boundary articles three subcategories can be distinguished with respect to the neuroimaging research outcomes presented. 95 percent (n=106) of these articles could be placed in one (n=99) or more (n=7) of these subcategories. The remaining five percent (n=6) describe merely a numeration of neuroimaging use, without elaborating on the (potential) outcomes, and can therefore not be placed in any of the subcategories. We describe the subcategories below.

5.5.1 From medical towards non-medical applications

14 of the boundary articles report on neuroimaging research that may lead to medical applications that result in non-medical applications as well. In other words, the domain of application transcends the medical domain. Described examples are the use of medication for enhancement purposes, e.g. "healthy brain could become super brain" (van Hintum, 2007), and the use of medical gaming applications in a leisure setting, for example:

> *The most spectacular was the use of Brain Computer Interaction in games. Up to now, this technique is mainly used for medical purposes. A common example is a disabled person who controls a cursor with his thoughts. Researchers at the University of Twente accomplished to have someone's mood determine his or her role in the game. Brain activity was measured among active players of the online game "World of Warcraft". When the gamer is calm, he plays a druid or fairy. However, the quiet fairy turns into an aggressive bear, once the player gets agitated. By bringing oneself to certain mood, one can change one's role in the game.* (Met gedachten de computer besturen, 2009)

Furthermore, the use of neuroimaging technologies to measure cognitive processes outside the medical domain is presented, for example to determine whether someone is guilty or not in a judicial context:

> *As with the sweat meter, an EEG can make the presence of perpetrator knowledge 'unambiguously' plausible (...) Will the white coats help the black toga gowns with irrefutable evidence of defects under the hood, thereby no longer to be attributed to the individual?* (Jensma, Sorry edelachtbare, het was mijn brein, 2007)

5.5.2 From research into behaviours and feelings towards medical insights and solutions

In 54 of the boundary articles presented neuroimaging research relates to the functioning of the brain and the neurobiological origin of certain behaviour or feelings to obtain medical insights and solutions. With this, the medical application is presented as a substantiation why neuroimaging research into 'normal' (in the sense of not disorder-related) functioning of the 'healthy' brain is relevant and important. Examples are neuroimaging research into meditation that is presented as relevant as it might serve as treatment for depression (Korteweg, 2009) and research into the functioning of the brain in language processing in order to find insights and solutions for dyslexia or schizophrenia. As explained in one of the articles:

> *The role of the right hemisphere for language functions in 'healthy' people is usually small. However, in schizophrenic persons this part of the brain appears to be active. Scientists call this a "low brain dominance": the hemisphere that usually dominates – the left one - is less active in these persons.* (Gebruik beide hersenhelften bij taal, 2004)

Another example is neuroimaging research into 'normal' behaviour that provides insights and potential solutions for 'deviating' behaviour, which can be clinically relevant. For example:

> *Holstege sees his research on the brain activity during orgasms […] as the basis for possible therapies for sexual dysfunction.* (Kohler, 2003)

Other articles in this sub-category describe how certain feelings result in behaviour, which can be explained as the result of a brain 'dysfunction' or 'disorder'. A deterministic line of reasoning takes place in these articles: because the underlying mechanisms of feelings and hence behaviour are located in the brain, one cannot do anything about these feelings and resulting behaviour, because it is located in the brain. This is illustrated in the following example:

> *It is good to know that unrestrained appetite and cravings have such a basic biochemical background, according to the researchers. That chemistry varies, that not everyone's brain is equally sensitive to inhibitory signals. Maybe that helps outsiders to judge more carefully when they see an 'undisciplined podge' consume another slice of pie.* (van der Laan, 2007)

5.5.3 Connections between brain disorders and lifestyle, behaviour and environment

The third sub-category of boundary articles (n=45) contains articles that describe the influence of infirmities of old age, life style habits (e.g. addictions, playing computer games) and the environment (e.g. electromagnetic fields, urban life) on the brain. Subsequently, conclusions are drawn about consequences for health and behaviour. These articles connect daily life and 'normal' behaviour and phenomena with brain disorders or *vice versa*. Although articles focus on a lifestyle, environmental factor, aging or a brain disorder, connections are made from one 'domain' to another, i.e. from medical to non-medical, resulting in articles that report about: a) brain disorders that lead to certain behaviours. For example:

> *Alcoholism is common in families of hyperactive children. We think that these people had ADHD as a child, and their desire for more and better stimuli are converted into a desire for alcohol.* (Didde, 1995)

And the other way around, b) behaviour, lifestyle and/or environmental factors that lead to brain disorders:

> *Long it has been thought that hyperactive children suffered from brain damage during labour. That idea is outdated. Entirely different causes play a role, such as excessive drinking during pregnancy or complications of a childhood disease. But genetic predisposition and environmental factors are even more important.* (Didde, 1995)

Or c) a certain behaviour, lifestyle and/or environmental factor that prevents development of a brain disorder:

> *The radiation of mobile phones could even protect against Alzheimer's disease. (*Mobieltje goed voor muizenbrein, 2010)

5.6 Analysis of potential performative forces of neuroimaging research framing

In analysing the potential performative force of an article we noticed that this is the result of the framing of neuroimaging research *outcomes***,** comprising new knowledge and applications that result from neuroimaging research, combined with the framing of neuroimaging *research* as a practice. In other words, how the outcomes of neuroimaging research and neuroimaging research in itself are defined and constructed together determine the potential effect the framing might have on the reasoning and behaviour of those reading the article. Although the framings are interrelated, for analytical purposes it is useful to make a distinction between the framing of neuroimaging research outcomes and of neuroimaging research as a practice. In section 5.6.1, we first describe ways in which outcomes from neuroimaging research are framed, followed by a description how neuroimaging research itself is framed in section 5.6.2. Subsequently we show how the two framings are related to each other. In section 5.6.3 we present how the combination of the framing of the outcomes and neuroimaging research determine the potential performative force of an article.

5.6.1 Framing of neuroimaging research outcomes: reassertion or contestation

Presented outcomes are framed in a reasserting or contesting way. Some articles display a combination of both. In articles in which outcomes are placed in a reasserting frame, there is a reassertion of the common discourse on scientific research that results from scientific research contributes to benefit humanity. In other words, outcomes presented in a reasserting frame describe positive outcomes of neuroimaging research. For example:

> *Letter by letter the answer appeared on the screen: '- I N D I A -'. It worked! With his thoughts, one subject was able to tell in which country he had been on holiday. Researchers from Maastricht University described last week how they could let people answer open questions without having talked or moved through so-called functional MRI.* (Voormolen, 2012)

Articles in which outcomes are placed in a frame of contestation, frame outcomes of neuroimaging research in a more negative way. They focus on (potential) negative consequences that might result from the outcomes and/or question the validity of the outcomes. For example:

> *Look, that's an advice that makes no sense. First, ventral striatum are visible in almost every experiment, because it is involved in almost every action we take. Emotions just play a big role in our lives. [...] MRI scans are meanwhile old school, but to draw conclusions based on illuminating brain regions and sweaty hands about remorse and emotion management and even give lifestyle advice goes very far.* (van Maanen, 2012)

In the majority of the articles the outcomes presented are exclusively put in a frame of reassertion (n=263) and in only a small fraction outcomes are exclusively contested (n=15). Except for one instance, outcomes presented were not contested in articles of regional newspapers. In 29 articles a combination of reassertion and contestation was observed. Articles that contained a degree of contestation are also often classified in our analysis as 'response articles' (n=21). In other words, in articles that are written in response to earlier 'reasserting' publications it is more likely that the outcomes of neuroimaging research are contested. In articles that are not written in response to earlier publications, outcomes are more likely to be reaffirmed. Both demonstrated an extremely statistically significant association ($p<0.0001$). We also observed that the degree of contestation or reassertion relates to the framing and subject matter (see

section 5.4.2). Regarding the framing, there is a statistically significant association for the absence of a frame of reassertion when purely non-medical articles are compared with articles that contained some degree of a medical frame (i.e. 'medical' and 'boundary' articles) ($p<0.0116$). This means that articles written within a non-medical perspective are more likely to not present a frame of reassertion with respect to the described outcomes. Most noticeable and statistically significant for increased contestation of outcomes were articles describing outcomes related to subjects of safety and security (e.g. criminality, security officers, aggression, decisions and behaviours in judicial or security context), and spirituality (near-death experiences, meditation, religion) (p-values are 0.0013 and 0.0112, respectively).

5.6.2 Framing of neuroimaging research

We can distinguish four different framings of how neuroimaging research as a practice is presented. The act of research is defined and constructed as: 1) providing insight and solutions, 2) trendy and innovative, 3) providing potential negative consequences or, as 4) unilateral and limited.

In most articles (n=251) neuroimaging research is presented ***as providing insights and solutions*** with respect to the brain and its (dys)functions. In this frame there is a reassertion of the common discourse on scientific research: research provides on the one hand knowledge, giving us insights into the previously unknown, and on the other hand yield solutions. In 19 articles neuroimaging research is framed as *trendy and innovative***.** The difference between these two framings of neuroimaging research is in the words chosen to describe the research: more or less 'neutral' for the 'insights and solutions' frame and more suggestive language use for the 'trendy and innovative' frame. For example:

> *Five years later he devised an even more astonishing experiment: a monkey that made a robot walk, once again by only thinking about it. Behold, the wonderful world of Nicolelis*[14]*, in which our thoughts can bring machines to life.* (Keulemans, 2011)

In a minority of the articles (n=2) neuroimaging research is framed in a more negative way, as *providing potential negative consequences*. In this frame, the focus is on the potential negative consequences the act of neuroimaging research provides. It gives a warning that neuroimaging research needs at least careful consideration before continuation. For example:

[14] Miguel Nicholelis is a neuroscientist, specialised in brain computer interfaces.

> *But how promising is promising? And what does 95 percent reliability mean in practice? Can justice use a fMRI scanner in the future to view whether TBS convicted paedophiles are ready to return to society?* (ten Broeke, 2011)

In 15 articles neuroimaging research is framed as **unilateral and limited**. In these articles the validity of the research and/or its outcomes are questioned and with this positioned as unilateral and/or limited.

> *It depends how you look at it. If brain scans are compared between a group of 432 adults with migraine and a group of 435 adults without migraine, and more brain damage is statistically detected in the migraine group than in the non-migraine group, then the medical researcher concludes that migraine attacks can cause brain damage. A remarkable conclusion. I, as a non-researcher, know that the non-migraine group never used migraine medications and the migraine group regularly. So I could just as well conclude that the alleged brain damage in the migraine group is caused by migraine medications.* (van de Ven Heesch, 2004)

The remaining 39 articles display not a single framing of neuroimaging research, but present two (n=36) or three (n=3) frames of neuroimaging research, see Table 5.2.

Regarding the framing – medical, non-medical or boundary - we only found statistically significant associations relating to the frames of research, when comparing articles with a non-medical framing to the combined set of boundary articles and articles having a medical framing. In other words, the boundary articles were almost similar to the articles having a singularly medical framing in this respect. When non-medical articles are compared with articles that contain some degree of medical perspective (i.e. 'non-medical' articles versus 'medical' and 'boundary' articles), there is a statistically significant association for framing neuroimaging research as unilateral and limited and/or as potential negative ($p=0.0238$) and an association for framing research not as providing insights and solutions and/or trendy and innovative ($p=0.0165$). In other words, articles written from a non-medical perspective are more likely to present a neuroimaging research frame of unilateral and limited and/or potential negative when compared to articles that contain (to some extent) a medical perspective.

Table 5.2. Prevalence of neuroimaging research and neuroimaging outcomes frames

	Exclusive frame of reassertion (263)	Exclusively contested knowledge (15)	Reassertion and contested knowledge (29)	Total (307)
Exclusive prevalence of:				
Insights, solutions	**242** m76/ n78/b88	**0**	**9** m2/n2/b5	**251**
Trendy innovative	**0**	**0**	**0**	**0**
Unilateral, limited	**0**	**14** m3/n9/b2	**1** m0/n0/b1	**15**
Potential negative	**0**	**0**	**2** m0/n1/b1	**2**
Combination of:				
Insights, solutions + trendy, innovative	**19** m3/n8/b8	**0**	**1** m0/n0/b1	**20**
Unilateral, limited + potential negative	**0**	**1** m0/n1/b0	**0**	**1**
Insights, solutions + unilateral, limited	**1** m0/n1/b0	**0**	**10** m4/n4/b2	**11**
Insights, solutions + potential negative	**1** m0/n0/b1	**0**	**3** m0/n0/b3	**4**
Insights, solutions + unilateral, limited + potential negative	**0**	**0**	**2** m0/n2/b0	**2**
Insights, solutions + trendy, innovative + unilateral, limited	**0**	**0**	**1** m0/n1/b0	**1**
Total	263	15	29	307
Non-exclusive prevalence of:				
Insights, solutions	**263**	**0**	**26**	**289**
Trendy, innovative	**19**	**0**	**2**	**21**
Unilateral, limited	**1**	**15**	**14**	**30**
Potential negative	**1**	**1**	**8**	**10**

m: articles written from an exclusively medical framing; **n**: articles written from an exclusively non-medical framing; **b**: articles written from both a medical and a non-medical framing, i.e. boundary articles

Relations between frames of outcomes and frames of neuroimaging research

In the majority of articles (n=242) in which outcomes are exclusively put in a frame of *reassertion*, neuroimaging research is exclusively framed as *providing insights and solutions*. In another 19 articles this discourse is also visible, but neuroimaging research is additionally structured as *trendy and innovative*, see Table 5.2. Articles in which the outcomes are exclusively put in a frame of *contestation* (n=15) frame neuroimaging

research as *unilateral and limited* (n=14), and once in combination with the research frame of *providing potential negative consequences*.

In 9 of the 29 articles in which outcomes are both reasserted and contested, the frame of neuroimaging research is that of leading to insights and solutions. In another 10 articles this frame is combined with a frame of neuroimaging research as unilateral and limited. In these articles, outcomes that are contested are used to position the (new) outcomes following from neuroimaging research as 'better' outcomes. In these articles the idea of progress (we used to believe this, but now we know that …), or the duty to educate (many believe this, but actually it is otherwise) have a central place. Therefore, although some outcomes were contested, these articles still position neuroimaging research as providing insights and solutions.

Overall, articles in which the outcomes presented are put in a frame of reassertion, are more likely to present a frame of neuroimaging research as providing 'insight or solutions' and research being 'innovative and trendy', as compared with articles that contest the described outcomes ($p<0.0001$). In contrast, articles in which the outcomes described are contested are more likely to frame neuroimaging research as "unilateral and limited" and as providing "potential negative" consequences ($p<0.0001$).

5.6.3 Potential performative forces

Together the framing of neuroimaging research outcomes and the framing of neuroimaging research as a practice determine the potential performative force of the article. We identified four potential performative forces with respect to neuroimaging research and its outcomes in the corpus of articles analysed: 1) a supportive performative force, 2) a performative force that society should adjust towards new insights, 3) a performative force in which the added value is questioned and 4) opposition, see also Figure 5.1.

In articles displaying the *supportive performative force*, neuroimaging research is presented as (ultimately) leading to new insights and solutions and therefore neuroimaging research should be continued, i.e. supported. In line with the framing of neuroimaging research as providing insights and solutions, the supportive performative force is a reassertion of the common discourse on scientific research and is mainly implicit visible in the articles.

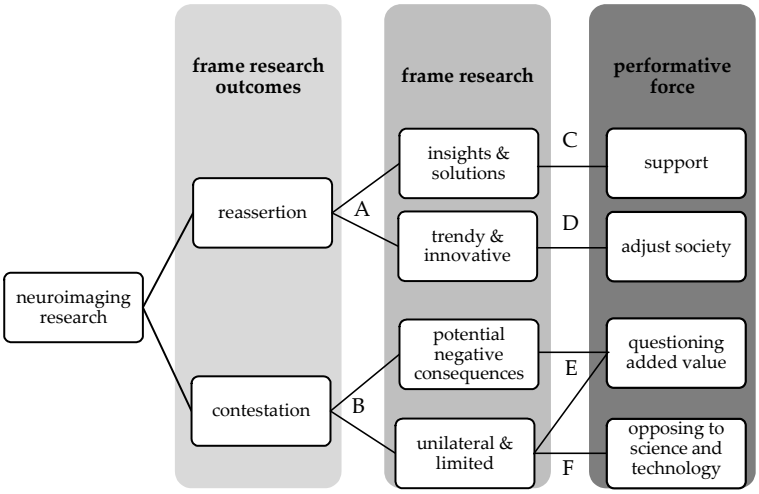

Figure 5.1. Statistical calculations (two-tailed Fisher's Exact Test) show significant associations between the 'frame outcomes', 'frame research' and resulting 'performative force'. When comparing the groups of 'reasserted outcomes' and 'contested outcomes', associations were found with the research frames of 'insights, solutions' and 'trendy, innovative' for the former (A: $p<0.0001$) and with 'unilateral, unlimited' and 'potential negative' for the latter (B: $p<0.0001$). C: 'insights, solutions' was positively associated with 'support' and negatively with the performative forces 'opposing science and technology' and 'questioning added value' of science and technology (all $p<0.0001$). D: 'trendy, innovative' was positively associated with 'adjust to outcomes' ($p=0.0002$) but no other statistically relevant associations were found. E: 'potential negative' consequences of science and technology were positively associated with 'questioning the added value' of science and technology ($p<0.0001$). F: 'unilateral, limited' was positively associated with both 'opposing science and technology' and 'questioning the added value' of science and technology ($p<0.0001$) and negatively associated with the performative force of 'support' ($p<0.0001$).

As a second performative force, we identified articles implying that *society should adjust* towards these new insights is such a way that it is in line with the scientific findings. Articles are more likely to contain elements implying that society should adjust towards new insights when articles frame neuroimaging research as trendy and innovative ($p=0.0002$). For example adjustment in the system of law and penalties:

> *Perhaps freedom of thought and action of people is more limited than we think. At the moment, intention is not considered proven on grounds of what was going on in someone's brain, but on the basis of observable facts. It fits into the legal system to have more sympathy for unconsciously impulsive behaviour that was neuroscientifically predictable, than for calculated crimes.* (van Hintum, Mijn brein heeft het gedaan, 2012)

Or in the field of neuromarketing:

> *People think they choose a car brand or model on rational grounds, but a car is the most emotional product there is. With our scans we can now predict this emotion and the ultimate consumer choice with seventy percent certainty," says Lamme [...] "The standard today to put a car in the wind tunnel, will also apply to the MRI scan in the future," predicts Lamme. "So that the car will have the type of look that makes us happy. This will certainly make things look prettier.* (Langenveld, 2012)

Indeed, this potential performative force is more or less an extension of the performative force of 'support', i.e. we support, thus we should adjust, and therefore most of the time the performative force of 'adjust' is present in combination with the potential performative force of 'support'.

Articles presenting the performative force of *questioning the added value*, question the added value of neuroimaging research and its outcomes. The effect of this potential performative force might be to downplay overly positivist conceptions of neuroimaging and/or to give a warning that neuroimaging research should be given careful consideration before continuation. For example, which dysfunctions should be classified as disorders? What is responsibility and when are people accountable for their acts? As shown in the following example:

> *With the rapidly growing knowledge about the brain, new moral issues also emerge. Can an offender be punished for the actions of his subconscious? Do we need to compete with someone in the future who is artificially made more creative and productive?* (de Schipper, 2004)

As a fourth potential performative force, we identified *opposition*. This opposition is either towards science, the neuroimaging technology itself or the outcomes and consequences the technology is envisioned to have. As illustrated in the following cynical quote:

> *The Health Council should have advised against further research, for the time being. Give the psychiatrists a few little years to learn this magnet trick. And then harvest the anecdotal "proof" that will undoubtedly pop-up. If it would turn out that especially redheads with a cat as a pet will benefit from TMS, then that is a bonus - and a good basis for further research.* (Ovulerende vrouw valt op mannelijke man, 2008)

Relations between frames of outcomes, neuroimaging research and potential performative force

The majority of the articles (84%), frame neuroimaging research outcomes exclusively in a reasserting frame and frame neuroimaging research as providing insights and solutions or as providing insights and solutions combined with a trendy and innovative research frame, resulting in a potential supportive performative force (see also Table 5.3).

Table 5.3. Frames of outcomes, research and related potential performative force(s)

Frame of outcomes	Frame of research	Related potential performative force(s)
263 reassertion m79/n87/b97	242 insights & solutions m76/n78/b88	240 support: m76/n77/b87 2 not possible to determine: m0/n1/b1
	19 insights & solutions + trendy & innovative m3/n8/b8	15 support: m2/n5/b8 3 support & adjust: m1/n2/b0 1 support & question: m0/n1/b0
	1 insight & solutions + unilateral & limited m0/n1/b0	1 support & questioning: m0/n1/b0
	1 insights & solutions + potential negative m0/n0/b1	1 support & questioning: m0/n0/b1
15 contestation m3/n10/b2	14 unilateral & limited m3/n9/b2	9 oppose: m2/n6/b1 4 questioning: m0/n3/b1 1 oppose & questioning: m1/n0/b0
	1 unilateral & limited + potential negative: m0/n1/b0	1 oppose: m0/n1/b0
29 reassertion + contestation m6/n10/b13	9 insights & solutions m2/n2/b5	7 support: m1/n1/b5 1 support & questioning: m1/n0/b0 1 support & oppose: m0/n1/b0
	1 unilateral & limited m0/n0/b1	1 questioning: m0/n0/b1
	2 potential negative m0/n1/b1	1 questioning: m0/n0/b1 1 support & questioning: m0/n1/b0
	1 insights & solutions + trendy & innovative m0/n0/b1	1 questioning: m0/n0/b1
	10 insights & solutions + unilateral & limited m4/n4/b2	5 support & questioning: m4/n1/b0 3 questioning: m0/n2/b1 1 support & oppose: m0/n0/b1 1 not possible to determine: m0/n1/b0
	3 insight & solutions + potential negative m0/n0/b3	1 questioning: m0/n0/b1 2 support & questioning: m0/n0/b2
	2 insights & solutions + unilateral & limited + potential negative m0/n2/b0	2 adjust & oppose: m0/n2/b0
	1 insights & solutions + trendy & innovative + unilateral & limited m0/n1/b0	1 adjust: m0/n1/b0

m: articles written from an exclusively medical perspective; **n**: articles written from an exclusively non-medical perspective; **b**: articles written from both a medical and a non-medical perspective, i.e. boundary articles.
For three articles we were not able to determine a performative force. These articles were too short to provide a clear view what the message of the article was.

In the set of articles in which outcomes of neuroimaging research are exclusively contested, neuroimaging research is framed as unilateral and limited and once in combination with a frame of potential negative, resulting in a performative force of questioning the added value and/or opposing science and technology. In articles in which outcomes from neuroimaging research were both contested and reasserted, the frame of research and resulting potential performative force are diverse. The majority of these articles frame neuroimaging research as providing insights and solutions and result in a potential supportive or questioning performative force.

Boundary articles

In Table 5.4 the boundary articles are separately featured. This Table shows that in the majority of the boundary articles outcomes are mainly reasserted, neuroimaging research is framed as providing insights and solutions resulting in a supportive performative force.

Mixed messages

Most of the articles have only one of the above described potential performative force (n=284, 93%) and 20 articles display multiple performative forces, see tables 5.3 and 5.4. Thirteen of these display outcomes of neuroimaging research that were both contested and reasserted, present different frames of neuroimaging research and have a combination of a supporting and/or adjusting performative force with a questioning and/or opposing performative force. Interestingly, these articles, all published in the national newspapers, were all written from 2006 onwards, and are more likely to be classified as a response/opinion article (p=0.0361). Five of these articles are written from a medical perspective, five from a non-medical perspective and three classify as boundary article. With respect to the latter, one article is part of the third subcategory 'lifestyle, behaviour and environment' and the other two articles are classified within the first subcategory 'from medical towards non-medical applications'. These articles discuss and/or question technical issues related to neuroimaging, for example its reliability and validity, and include ethical discussions or questions, for example issues of privacy and accountability, which we were not able to find in articles resulting in a supportive and/or adjusting performative force.

Table 5.4. Frames of outcomes, frames of research and related potential performative force(s) boundary articles

	Frame of outcomes	Frame of research	Potential performative force(s)
1. From medical to non-medical (14)	8 reassertion	4 insights & solutions	7 support
		3 insight & solutions + trendy & innovative	
		1 insights & solutions + potential negative	1 support + questioning
	6 reassertion + contestation	1 insights & solutions + trendy & innovative	1 questioning
		1 insights & solutions + potential negative	1 support + questioning
		2 insights & solutions + unilateral & limited + potential negative	1 questioning 1 support + questioning
		1 unilateral & limited	1 questioning
		1 potential negative	1 questioning
2. From behaviour and feelings to medical insights & applications (54)	49 reassertion	43 insights & solutions	49 support
		6 insights & solutions + trendy & innovative	
	5 reassertion + contestation	4 insights & solutions	4 support
		1 unilateral & limited	1 questioning
3. Connections between brain disorders, life styles, behaviour & environment (45)	38 reassertion	37 insights & solutions	38 support
		1 insights & solutions + trendy & innovative	
	5 reassertion + contestation	3 insights & solutions	3 support
		2 insights & solutions + unilateral & limited	1 support + questioning 1 questioning
	2 contestation	2 unilateral & limited	1 questioning 1 oppose
Other (6)	6 reassertion	6 insights & solutions	6 support
Total (119)*	101 reassertion 2 contestation 19 reassertion + contestation	97 insights & solutions 11 insights & solutions + trendy & innovative 2 insights & solutions + potential negative 2 insights & solutions + unilateral & limited + potential negative 2 insights & solutions + unilateral & limited 4 unilateral & limited 1 potential negative	107 support 7 questioning 4 support + questioning 1 oppose

* The numbers do not represent unique articles, because seven articles present two categories.

5. 7 Conclusions and discussion

5.7.1 Neuroimaging research in Dutch newspapers

This research shows how neuroimaging research is framed in 307 Dutch newspapers from October 1992 to December 2012 and which effect this might have on their readers. Our analysis shows that the potential performative force of an article ensues from the framing of neuroimaging research *outcomes* combined with the framing of neuroimaging *research* itself. In other words, how the outcomes of neuroimaging research and neuroimaging research as a practice is defined and constructed together determine the potential influence on those reading the article.

The majority of the articles describe neuroimaging outcomes in a reasserting way and present neuroimaging research as providing insights and solutions (n=263). A small fraction (19/263) of these articles frames the research additionally as being trendy and innovative. These framings result in a potential supportive performative force regarding neuroimaging research. A few articles result additionally in a potential performative force that society should adjust to the outcomes and another few result in the additional performative force of questioning the added value of neuroimaging research and its outcomes. In a small fraction of the analysed articles (n=29) the outcomes of neuroimaging research were both contested and reasserted. Most of these articles portray contested outcomes in order to make the argument of the article stronger, that is to frame neuroimaging research as leading to insights and solutions and therefore result in a potential supportive performative force of neuroimaging research. A few of these articles frame neuroimaging research as unilateral and limited or as potential negative which results in a potentially cautioning performative force. Here, the potential performative force is to question the outcomes of some types of research that could possibly have (major) implications for the current structure of society. Articles that contest outcomes of neuroimaging research (n=15), frame neuroimaging research as unilateral and limited and result in a performative force that opposes science and/or neuroimaging technologies itself or its consequences and/or questions the added value of neuroimaging research.

We were able to identify 13 of the 307 articles that gave multiple framings of neuroimaging research outcomes and neuroimaging research as a practice that resulted in providing multiple performative forces. These articles show combinations of the potential performative forces of support or adjust on the one hand and opposing or questioning on the other hand. They provide a more or less 'balanced' overview by providing the reader with multiple frames of outcomes, research and resulting poten-

tial performative forces and let the reader decide which of the presented frames and resulting performative forces appeals most.

In conclusion, neuroimaging research is mainly presented in Dutch newspapers as providing insights and solutions for societal problems that should be supported. The importance of science to society is reasserted through this media coverage on neuroimaging research. Neuroimaging itself is then framed as a tool that provides reliable measurements on real-life phenomena, such as health, behaviour and experiences. In 65% of the articles at least one medical application of neuroimaging was of relevance to the message of the article.

5.7.2 Emerging frames: future topics of public debate?

Some boundary articles describe that one cannot influence certain feelings and resulting behaviour because the underlying mechanisms hereof are located in the brain, which results in a deterministic line of reasoning. This applies for feelings and behaviours that are classified as 'normal', as well as for those classified as 'deviant'. Furthermore, medicalisation becomes apparent in the set of boundary articles, as the described outcomes seem to contribute to viewing otherwise everyday phenomena and behaviours as medical issues. In doing so, the medical domain seems to be enlarged with previously 'not acknowledged' disorders, such as obesity (e.g. brain is not sensitive to inhibitory signals) or sexual dysfunction (e.g. deviating brain activity). These articles therefore seem to justify the idea that medical knowledge can be (somewhat) straightforwardly translated to other societal domains.

However, of the 112 boundary articles only one results in a potential opposing performative force; seven in a performative force of questioning the added value of neuroimaging research; and four times in a combined questioning and supportive performative force. The remaining majority result in a supportive performative force. This could imply that future tensions and/or topics of debate are not being identified in our emerging frames. Articles that result in a potential opposing performative force are mainly found in articles written from a *non-medical* framing describing neuroimaging applications outside the medial domain, such as in the context of safety and security. In addition, half of the boundary articles describing medical applications that result in non-medical applications as well (1st sub-category), result in a questioning performative force. This might indicate that potential future topics of debate are not that much related to emerging frames and themes of neuroimaging research, but are situated in those studies which do not relate to, at least to some extent, a medical practice.

We can relate our findings to the research of O'Connor et al. (2012). They show in their analysis of the portrayal of neuroscience research in the mainstream UK media, that clinical applications have a dominant position, but "neuroscience was more commonly represented as a domain of knowledge relevant to 'ordinary' thought and behaviour and immediate social concerns" (O'Connor et al., 2012, p. 225). This is in line with our rather large proportion of articles containing a non-medical framing to some extent (219/307). The emerging images of how neuroscience is represented in the media which they identified are also visible in our research, see Table 5.5 for an overview.

Table 5.5. Comparison with emerging themes of neurosciences representation in the UK mainstream media (O'Connor et al., 2012)

Emerging themes of neuroscience representation in the UK mainstream media (O'Connor et al., 2012)		**In this research**
The brain as capital	Enhance brain activity above normal or basis function Bypass potential threats for the brain	*First sub-category*: shift from medial to non-medical neuroimaging use, including neuroimaging use for enhancement purposes *Third sub-category*: the interconnection between lifestyle, behaviour, environmental factors and the brain from which conclusion are drawn about healthy and unhealthy lifestyles, i.e. bypass threats for the brain
The brain as index of difference	Neuroscientific findings to underline group-related brain differences that correspond with existing stereotypes. The brain is positioned as a classification instrument and a scientific 'engine for essentialism'	*Second sub-category*: neuroimaging research into 'normal' functioning of the 'healthy' brain is contrasted with the brain of groups of people that have a 'dysfunction', 'disorder, or 'deviating' behaviour to explain the differences between these two groups *non-medical category*: neuroimaging research outcomes to explain non-medical related group differences, such as male-female differences
The brain as biological proof	The brain as basis to explain particular beliefs and phenomena	*Non-medical category*: brain-based explanations for religious, meditation and near-death experiences

The main difference between the study of O'Connor et al. and our study is respectively the focus on how *the brain* as a result of neuroscientific findings is presented in the main-stream media versus the *potential performative force* the framing of neuroscientific findings might have on the reasoning and position taken by the reader with respect to neuroimaging research. The emerging images that capture how neuroscience/neuroimaging is presented in the media of O'Connor et al. can be related to

framings distinguished in our research, especially in our category of boundary articles and articles written from a non-medical framing, see Table 5.5. We can add to the typology of O'Connor that articles addressing the brain as *capital* and as *an index of difference* result in our study mainly with a supportive performative force. In a similar way, articles that frame the brain as *biological proof* regarding religious and spiritual experiences appear in our study with a supportive performative force in half of the articles and, in the other half, with a questioning and opposing potential performative force.

As O'Connor and colleagues point out, the framing of the brain will most likely have (future) influences on the reader's conceptual, behavioural and institutional repertoires. In other words, the emerging frames of the brain might influence the image the reader has of the brain, which subsequently might lead to changes in the framing of illness and health and (healthy) life style, hence a performative force. In almost half of the analysed articles exclusively presenting advantages of neuroimaging research, the brain is presented in an engineering or mechanistic framing. This might result in obtaining the idea that disorders, behaviours and feelings are located in the brain which can be (merely) influenced and 'solved' by repairing this 'dysfunction' in the brain. Moreover, the description of the brain as a more autonomous object in another significant part of these articles might result in the perception that behaviours and feelings are beyond one's control. This can, on the one hand, lead to the idea that the brain partly contains structures (e.g. nuclei, pathways and networks), which are testable and controllable. On the other hand, it can lead to the perception that other parts of the brain function on its own. For example, the brain determines personal characteristics and has power to explain differences between people. In other words, the framing of the brain in the media, based on neuroscientific research, might result in conflicting framings and visions of the brain (e.g. the mechanistic brain versus the autonomous brain) and potentially raise confusion, concerns and topics of debate.

Future topics of concern and debate in the Dutch media are most likely to be neuroimaging applications outside the medical realm or medicalisation discussions, related to brain-based explanations of social beliefs and phenomena (e.g. religious experiences), and non-medical related behaviours and dysfunctions (e.g. the determination of diminished capacity in the domain of justice). On the other hand, considering the many positive framings of neuroimaging research, it is plausible that the media frame neuroimaging in such a way that it addresses what their publics would like to read: perhaps hopeful futures in which for example disorders and misbehaviours can be prevented or otherwise cured, through science and technology. As

Poepsel (2011, p.26) explains: "When news organizations no longer have a monopoly over information in the "space of place" because society and culture are transitioning to a greater focus on the "space of flows," news organizations are finding they must adapt". In other words, in times where people no longer have to rely on newspapers to gather information, journalism becomes reciprocal. The boundaries between the makers and users of articles blurs (Deuze, 2008), possibly resulting in a majority of positive neuroimaging research framings in the media.

Methodological considerations

We only included articles that report about neuroimaging research, thereby excluding those articles reporting about neuroimaging without references to research. Generalisation of our results beyond the domain of neuroimaging research without additional analysis of media articles without references (i.e. opinions, columns, etcetera) is therefore not possible. Furthermore, our corpus of articles contained a minority of articles that show more negative points of view regarding neuroimaging research and its outcomes. Given that other similar studies also concluded that the number of articles that present more negative or pessimistic points of view were scarce (Racine et al., 2006; O'Connell, et al., 2011), our results are most likely representating the current state of coverage of neuroimaging research in Dutch newspapers.

5.7.3 Towards a balanced overview of neuroimaging possibilities and limitations in the media

Scientists consulted in previous phases of our research expressed concerns related to the, unrealistically high expectations of the general public about the possibilities and limitations of neuroimaging. These expectations are considered a barrier, as unrealistic expectations by the public will inevitably lead to disappointment. When the innovation has not lived up to its initial promise, a potential resulting loss of confidence in science might occur, resulting in damage of the reputation and credibility of scientists. The expectations are regarded as being caused by hypes and promises relating to neuroimaging in the mass media. To move towards a more responsible development and social embedding of neuroimaging, scientists consulted argue that more correct information about the possibilities and limitations of neuroimaging to society is required, that is a 'balanced overview'. According to them, this would prevent hype and horror stories in the mass media and result in the management of expectations of the general public(s) (details in Chapter 4).

Given the results presented here, one can doubt whether the current framing of neuroimaging research can be classified as 'balanced'. We show that media coverage on

neuroimaging research claims to inform citizens about the advantages of neuroimaging research, mostly framed in a promising way. With respect to the mitigation of high and/or unrealistic expectations, the situation can be considered fairly dismal. There are articles that give a more balanced view on neuroimaging research. These, however, seem to be a more recent phenomenon. If scientists are to strive for a more 'balanced' picture of the possibilities and limitations of neuroimaging in the mass media, this article offers opportunities for actors, and neuroscientists in particular, to reflect upon how their research (outcomes) are framed in the media, in order to address and correct current framings. Perhaps, they need to make clearer what the possibilities and impossibilities of their research are.